

(~0.75 in) in height, although, again, these dimensions are merely exemplary, and dimensions can vary widely for different embodiments.

**[0478]** While the principles of the invention have been described herein, it is to be understood by those skilled in the art that this description is made only by way of example and not as a limitation as to the scope of the invention. Other embodiments are contemplated within the scope of the present invention in addition to the exemplary embodiments shown and described herein. Modifications and substitutions by one of ordinary skill in the art are considered to be within the scope of the present invention.

What is claimed is:

1. The method to deliver therapeutic liquid comprising: acoustically exciting a gas in a fixed-volume chamber at a first frequency; sampling a plurality of signal pairs from a first microphone and a second microphone, the first microphone acoustically coupled to a fixed-volume chamber, the second microphone acoustically coupled to a variable chamber, the variable chamber acoustically coupled via a port to the fixed-volume chamber; determining a plurality of complex signal ratios of the signal pairs; determining the mean and variance of the plurality of real parts and plurality of imaginary parts of the complex signal ratios; determining a system fault based on the mean and variance; and alarming at a user interface when a system fault.
2. The method to deliver therapeutic liquid according to claim 1 wherein the system fault includes a fault in at least one of the first microphone, the second microphone, and a speaker.
3. The method to deliver therapeutic liquid according to claim 1 wherein the system fault includes at least one of liquid ingress, poor acoustic seal, excessive shock, excessive vibration and excessive ambient noise.
4. The method to deliver therapeutic liquid according to claim 1 wherein determining the system fault is further based on comparing the mean to a range of predetermined mean values.
5. The method to deliver therapeutic liquid according to claim 1 wherein determining the system fault is further based on comparing the variance to a range of predetermined variance values.
6. The method to deliver therapeutic liquid according to claim 1 further comprising sampling a temperature value from a temperature sensor.
7. The method to deliver therapeutic liquid comprising: acoustically exciting gas in a fixed-volume chamber at multiple frequencies; sampling a plurality of signal pairs from a first microphone and a second microphone at the multiple frequencies, the first microphone acoustically coupled to

- a fixed-volume chamber, the second microphone acoustically coupled to a variable chamber, the variable chamber acoustically coupled via a port to the fixed-volume chamber;
- determining a plurality of complex signal ratios of the plurality of signal pairs at each frequency;
- determining the mean and variance of the of real parts and of imaginary parts of the plurality of complex signal ratios at each frequency;
- determining a system fault based on the mean and variance for each frequency; and
- alarming at a user interface when a system fault.
8. The method to deliver therapeutic liquid according to claim 7 wherein the system fault includes a fault in at least one of the first microphone, the second microphone, and a speaker.
  9. The method to deliver therapeutic liquid according to claim 7 wherein the system fault includes at least one of liquid ingress, poor acoustic seal, excessive shock, excessive vibration and excessive ambient noise.
  10. The method to deliver therapeutic liquid according to claim 7 further comprising sampling a temperature value from a temperature sensor.
  11. The method to deliver therapeutic liquid comprising: acoustically exciting gas in a fixed-volume chamber at a plurality of frequencies; receiving a first signal at each frequency from a first microphone acoustically coupled to the fixed-volume chamber; receiving a second signal for each frequency from a second microphone acoustically coupled to a variable chamber, the variable chamber acoustically coupled via a port to the fixed-volume chamber; determining a real portion and an imaginary portion of a complex signal ratio of the second signal to the first signal for each frequency; determining the phase angle of the complex signal ratio as a function of frequency; determining the presence of a gas bubble in the dispensing volume by comparing the phase angle to a predefined phase angle; and alarming at a user interface when the presence of a gas bubble is determined.
  12. The method to deliver therapeutic liquid according to claim 7 wherein the phase angle of the complex signal ratio is the arctangent of the imaginary portion over real portion of the complex signal ratio.
  13. The method to deliver therapeutic liquid according to claim 7, further comprising determining a slope of the phase angle over the frequency based on a polynomial fit of the phase angle to the frequency.

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